ENDEVCO
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Media Compatibility
8500 Series Pressure Transducers

Technical Paper 338

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Many users of the Endevco 8500 series of pressure transducers have achieved excellent results measuring various liquid media. While there are exceptions, this paper will cover precautions to be observed when using liquids.

Diaphragm types

Miniature dynamic pressure transducers are available with a media[1] isolated diaphragm or a direct silicon diaphragm. When measuring fast events, the silicon diaphragm offers the highest resonance frequency and small size.

The 8500 series utilizes a silicon diaphragm. In this case, the piezoresistive gages are diffused (or implanted) directly into the diaphragm. There is no metal barrier between the silicon diaphragm and the media to be measured.

Media isolated transducers generally have a stainless steel diaphragm which isolates the sensor from the measurement media. The disadvantage of the isolated transducer is a reduction in the resonance frequency and often times a larger size.

While the Endevco pressure data sheets specify a measurement media consisting of "clean dry gas", liquid media can be measured if certain precautions are observed.

Pressure ports

During this discussion pressure ports will be referred to as the "Measurement Port" and the "Reference Port". In the case of absolute pressure transducers, the reference is a vacuum thus there is no external reference port. The reference port is the vent tube on the top of a gage transducer Figure 1.

Figure 1: 8510 series showing pressure and reference ports

When applying the measurement media to either port, one must take into account the materials used in the construction of these ports. On the measurement side, these will include the diaphragm, adhesive, coating, housing and the O-ring seal. If using the reference port, the internal components of the transducer must be taken into consideration.

Since it would not be possible to list all potential media, the below tables show what materials will be encountered at the pressure ports and reference ports, by model number

Gage pressure

Model number	Measurement port material	Reference port material
8507C	RTV, Parylene, silicon, N Fe alloy, solder glass	Epoxy, Pb, Sn, Parylene, NiFe alloy, circuit board[1], Al, stainless steel, solder glass
8510B (high)	Epoxy, Parylene, silicon, stainless steel, ceramic, solder glass	Epoxy, ceramic, Pb, Sn, stainless steel, circuit board
8510B (low -1,-2,-5)	Epoxy, Parylene, silicon, stainless steel, ceramic, solder glass, NiFe alloy	Epoxy, NiFe alloy, Pb, Sn, stainless steel, circuit board, Al, solder glass
8510C-15,-50	RTV, Parylene, silicon, stainless steel, ceramic, Epoxy	Epoxy, Pb, Sn, stainless steel, circuit board, Al, solder glass
8510C-100	Parylene, silicon, stainless steel, ceramic, epoxy solder glass	Epoxy, Pb, Sn, stainless steel, circuit board, Al, solder glass
8511A	Epoxy, Parylene, silicon, stainless steel, solder glass	N/A, reference port accessed through cable

Absolute pressure

Model number	Measurement port material	Reference port
8515C	Epoxy, Parylene, silicon, RTV, circuit board[1], stainless steel, Al, ceramic, Pb, Sn, solder glass	N/A, vacuum reference
8530B	Epoxy, Parylene, silicon, stainless steel, ceramic, solder glass	N/A, vacuum reference
8530C -15, -50	Epoxy, Parylene, silicon, stainless steel	N/A, vacuum reference
8530C-100	Epoxy, Parylene, silicon, stainless steel, ceramic, solder glass	N/A, vacuum reference
8540	Polyimide, Epoxy, silicon, RTV, ceramic, stainless steel, solder glass	N/A, vacuum reference

[1] Circuit board consists of copper, gold, tin, lead, kapton, polyimide and nickel

Liquid media requirements

In general, the media should be non-conductive exhibiting a high to infinite resistance. It should also have a neutral pH around 6.5 to 7.5. While an infinite media resistance is the most desirable, a high resistance is acceptable.

While the above paragraph states that the media is to be non-conductive, a conductive media may be used, but with some caveats. First, the media must be compatible with the materials present in the transducer's measurement ports. There will be a time limit before the media penetrates the Paralyne coating then the transducer will be compromised. This time can vary from a few hours to a few days depending on the condition of the transducer, temperature, pressure applied and the media type.

The pH should also be observed. While a measurement medium with a high or low pH can be used, it may cause permanent damage to the transducer. It is recommended that the pH be as close to neutral (7.5) as possible.

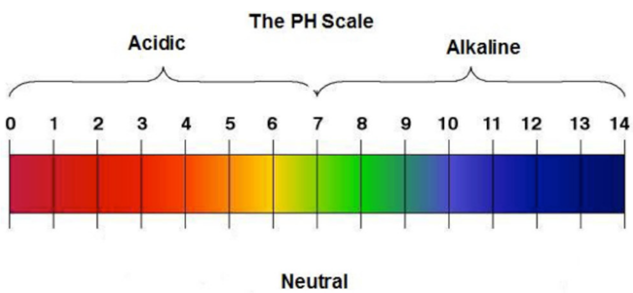

Figure 2: The pH scale showing neutral pH at 7

Identifying media ingression

When working with liquid media, it is recommended that the user monitor both the ZMO and the output signal from the transducer. Suggested equipment is an oscilloscope and a TRMS AC voltmeter. A DAQ may also be used if the scope and voltmeter functions are present. For convenience, the measurements are generally made from the output of the signal conditioner so noise will be added by the conditioner electronics.

If a significant shift in the ZMO is observed, it can be assumed that the transducer's seal has been penetrated. Chart 1 is an example of media penetration observed on some sample transducers.

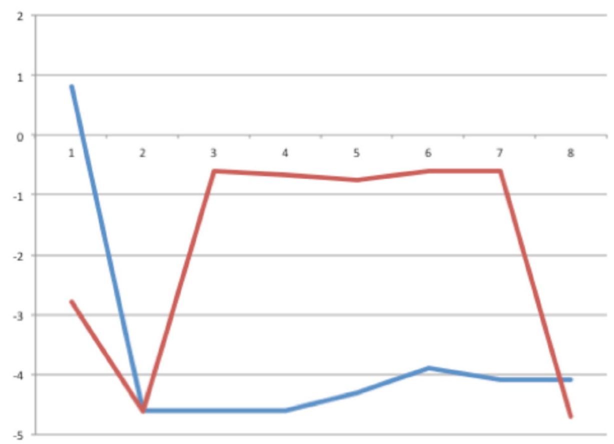

Chart 1: ZMO shift in mV vs. time in days. Red trace is concentrated antifreeze and the blue is tap water. Some of the initial shift is attributed to temperature change.

Tests show that while distilled water is an insulator, it can acquire contaminants causing a decrease in resistance. In tests conducted at Endevco, resistances of 20kΩ were observed using a commercial grade of distilled water.

ZMO shifts are the result of deformation of the die caused by changes in stress as the mounting material is altered. Also conductive media intrusion places an electrical load across terminals of the pressure sensor causing ZMO shifts. Chart 2 is a simulation of the results of parallel resistances placed across the output leads of an 8510B pressure transducer. The simulation is one scenario and is by no means the complete picture.

An extreme increase in the noise level is another indication of media ingression. Figure 3 is but one example of tap water intrusion into an 8510B.

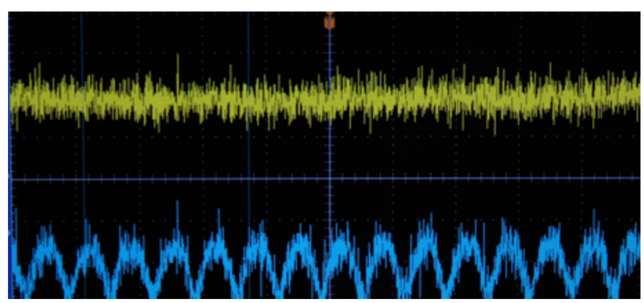

Figure 3: Yellow trace is the transducers noise level before ingression. The blue trace shows the noise level after water ingression.

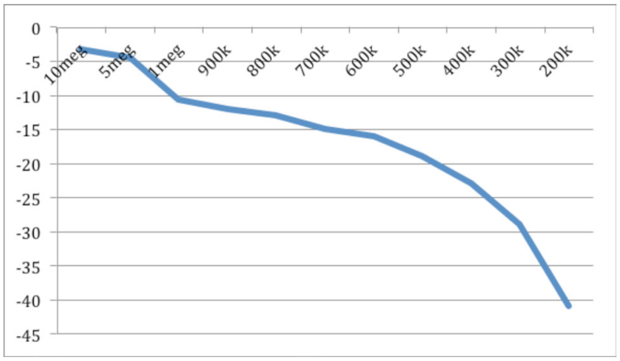

Chart 2: Effect of loading the output of a 8510B pressure transducer. At 10 meg Ω the ZMO has returned to its pre-resistive loaded value.

Recovery from media ingression

Depending on the media, the transducers can be restored to operation after ingression. If the media caused permanent damage, then recovery is not possible.

A common occurrence is tap water ingression. In almost every case recovery is possible. To affect recovery, the transducers are placed in an oven set for a temperature of ›212°F (100°C), but less than the maximum operating temperature. They should bake for about two hours after which they should be ready for re-use. Allow the transducers to reach room temperature and ensure that the ZMO is within a few millivolts of the original measured value. The ZMO value will be on the calibration certificate.

Known safe media

Based on user reports distilled water, most hydraulic oils, gasoline, diesel fuel and jet fuel are compatible products. Note that a laboratory grade of distilled water should be used since contaminants can cause a decrease in resistance. Caution should be exercised when testing gasoline or other volatile products.

Summary

Many liquids can be measured using Endevco silicon diaphragm pressure transducers, precautions must be observed. In many cases, these transducers can be bake-dried out and reused many times. Silicon diaphragm transducers are often preferred because of their high resonance frequency and miniature size.

References

[1] Media is defined as any chemical compound (solid or gas), being measured, that interacts with the sensor, the sensors coating or mounting adhesive, etc